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Title of the Invention: Optical Disk Label Printing Method And Optical Disk Apparatus And Optical Disk

(Scope of the Patent's Claims)

(Claim 1)

An optical disk label printing method, wherein a visible light reflection characteristics changing layer is formed, enabling to change reflection characteristics of visible light from the side of the label surface through irradiation with laser light having specific characteristics from the side of the label surface, in a location visible from the label surface side of an optical disk;

wherein said optical disk is set on a turntable of an optical disk apparatus so that the label surface is set to face the side of incident laser light emitted from an optical pickup, and relative movement of said disk and of said laser light is induced along the surface of the optical disk;

the laser light, synchronized with this relative movement, irradiates said visible light reflection characteristics changing layer from the side of said label surface, modulating said characteristics in accordance with image data such as letters, pictures, or the like to be printed;

so that the reflection characteristics of the visible light in the visible light reflection characteristics changing layer are changed by this irradiation;

with an optical disk label printing method for printing of corresponding images on the surface of a label.

(Claim 2)

The optical disk label printing method described in claim 1, wherein laser light having said specified characteristics is laser light above a specified power.

(Claim 3)

The optical disk label printing method described in claim 1, wherein said laser light is rotated, and said optical pickup is moved in the direction of the diameter of the optical disk.

(Claim 4)

The optical disk label printing method described in claim 1, wherein said optical disk is brought to a stationary position, and said optical pickup is moved in the direction of the diameter of the optical disk and in the track linear direction orthogonal to the direction of the diameter of the optical disk.

(Claim 5)

An optical disk, equipped with a relative movement apparatus inducing relative movement along the surface of an optical disk of laser light emitted from an optical pickup of an optical disk, set so as to face the side of incident laser light striking the label surface on a turntable;

[page 2]

equipped with a laser modulation circuit modulating specific characteristics of laser light emitted from said optical pickup;

and with a control circuit for said laser modulation circuit and said relative movement circuit;

wherein said control circuit controls said relative movement mechanism and moves said optical disk and said laser light, said laser modulation circuit modulates said specific characteristics of the image data with the laser light emitted from said optical pickup, control is exercised according to image data such as letters, pictures or the like so as to control relative movement and printing on the label surface of the optical disk;

and a corresponding image is formed in a location visible from the side of the label surface of the optical disk;

enabling to control printing by changing the reflection characteristics of visible light in a visible light reflection characteristics changing layer through irradiation with laser light having said specific characteristics.

(Claim 6)

The optical disk apparatus described in claim 5, wherein said relative movement mechanism is equipped with a radial direction feed driving apparatus, which moves said optical pickup in the radial direction of said optical disk, and with a rotation driving apparatus driving and rotating a turntable;

wherein said control circuit controls both of these driving apparatuses, as well as the relative movement of said laser light.

(Claim 7)

The optical disk apparatus described in claim 6, wherein said control circuit drives said rotation driving apparatus with a constant number of rotations, and said radial direction feed driving apparatus is driven with a constant amount per each specified rotational position.

(Claim 8)

The optical disk apparatus described in claim 6 or 7, equipped with a circumferential direction position detection mechanisms detecting the circumferential position of said optical disk, as well as with a radial direction position detection mechanism detecting the position in the optical disk radial direction of the optical pickup;

wherein said control circuit controls laser rays emitted from said optical pickup and the detection position of both detection apparatuses, so as to modulate said specified characteristics in accordance with image data such as letters, pictures, or the like to be printed on the label surface of said optical disk.

(Claim 9)

The optical disk apparatus described in claim 8, wherein said circumferential direction position detection apparatus is equipped with a frequency generator generating frequency signal corresponding to the rotations generated by said rotation driving apparatus;

and with a multiplying device multiplying the frequency of the signal generated by said frequency generator.

[page 3]

(Claim 10)

The optical disk apparatus described in claim 5, wherein said relative movement mechanism is equipped with a radial direction feed driving apparatus driving said optical pickup in the radial direction of said optical disk;

and with a track linear direction feed apparatus driving said optical pickup in the track linear direction of said optical disk, orthogonal to the movement direction in the radial direction;

wherein said control circuit controls the relative movement of said optical disk and of said laser light, and both driving apparatuses are controlled during the state when said turntable is put in the stationary status.

(Claim 11)

The optical disk apparatus described in claim 10, equipped with a radial direction position detection apparatus detecting the optical disk radial direction position of said optical pickup, and with a track linear direction position detection apparatus detecting the optical disk track linear direction position, orthogonal to the movement direction in the radial direction of the

optical disk of the optical pickup;

wherein said control circuit exercises control over the laser light emitted from said optical pickup, and over the detection position of both detection apparatuses, so as to modulate said specific characteristics in accordance with image data such as letters, pictures, or the like to be printed on the label surface of said optical disk.

(Claim 12)

The optical disk apparatus described in claim 5 ~ 11, wherein said control circuit sets the tracking servo OFF, and the focus servo ON, and performs the relative movement of said optical disk and of said laser light.

(Claim 13)

The optical disk apparatus described in claim 5 ~ 12, wherein while relative movement of said optical disk and of said laser light is performed by said control circuit, control is exercised over the oscillations and driving of the tracking actuator of said optical pickup.

(Claim 14)

An optical disk, wherein a visible light reflection characteristics changing layer is formed inseparably integrated, having reflection characteristics of visible light from the label surface side, which are changed through the irradiation of laser light with specific characteristics from the side of the label surface, in a location visible from the label surface side.

(Claim 15)

The optical disk described in claim 14, wherein said visible light reflection characteristics changing layer is a color changing layer whose color is changed by the irradiation with laser light having said specific characteristics.

[page 4]

(Claim 16)

The optical disk described in claim 15, wherein said color changing layer is a photosensitive layer or a thermosensitive layer.

(Claim 17)

The optical disk described in claim 14 ~ 16, wherein a sequential film construction is formed, comprising at least a recording layer, a reflection layer, and a protective layer, on the substrate of said optical disk.

(Claim 18)

The optical disk described in claim 17, wherein an intermediate layer is deployed between said reflection layer and said visible light reflection characteristics changing layer in order to improve the adhesion characteristics between the reflection layer and the visible light reflection characteristics changing layer.

(Claim 19)

The optical disk described in claim 17, provided with a part in which said visible light reflection characteristics changing layer is finely intermingled between said reflection layer and said protective layer;

and with a part in which said reflection layer is directly joined to the protective layer, while no visible light reflection characteristics changing layer is contained therein.

(Claim 20)

The optical disk described in claim 19, wherein said visible light reflection characteristics changing layer is formed with many dot shapes or with many apertures between said reflection layer and said protective layer, and wherein the reflection layer component is directly joined with the protective layer component on the outer side of the dots or on the inner side of the apertures.

(Detailed Explanation of the Invention)

(Sphere of Technology Belonging to the Invention)

This invention relates to an optical disk label printing method and to an optical disk apparatus, as well as to an optical disk, wherein printing is applied to a label surface by utilizing the laser light of an optical disk apparatus.

(0002)

(Prior Art Technology)

[page 5]

Recordable optical disks are provided with a record in which the user writes down information relating to the content of the recording (such as the title, etc.) for a visual confirmation of the content recorded on the optical disk. In this case, the use will generally write this record with a pen directly on the surface of the label of an optical disk with a single-surface optical disk, if a single-substance optical disk is used that can be accommodated in a cartridge, such as the CD type of an optical disk (CD-R, CD-recordable disk, or CD-RW, CD rewritable

disk). In addition, according to another method, the information relating to the content of the recording is edited with a personal computer, and this information is printed with a printer on a label and then pasted onto a label surface.

(0003)

(Problems To Be Solved By This Invention)

When a hard pen or the like was used for writing and a strong pressure is applied with the method when writing is performed directly with a pen onto the label surface of a disk, the recording layer was damaged by this in some cases. In addition, the problem with the method using a printer to print a label was that a separate printer was required.

In view of the above described problems, this invention provides an optical disk label printing method and an optical disk apparatus, as well as an optical disk that does not require printing with a pen or printing with a printer, so as to enable printing onto a label surface while utilizing the laser light of an optical laser apparatus.

(0004)

(Means To Solve Problems)

According to the label printing method of this invention, a layer having visible light reflection characteristics is formed, wherein by changing the reflection characteristics of the visible light from the label surface side through irradiation with laser light that has specific characteristics from the label side in a location visible on the label side of the optical disk. Said optical disk is set in a turntable of an optical disk apparatus so that its label surface is facing the side of incident laser rays, relative movement of said laser disk and of the laser light emitted from said optical pickup is initiated along the surface of the laser disk, the laser light emitted from said pickup is synchronized with this relative movement, said specific characteristics are modulated in accordance with image data such as letters or pictures or the like to be printed, the reflection characteristics of the visible light in the visible light reflection characteristics changing layer are changed with the irradiation, and an image is printed on the surface of the label.

[page 6]

Because according to this label printing method, a visible light reflection characteristics changing layer, formed in a location visible from the label surface side of an optical disk, is irradiated with the laser light of an optical disk apparatus, when the reflection characteristics of the visible light in this layer are changed, images such as corresponding letters or pictures or the like can be printed on the label surface. This makes it possible to render writing with a pen or printing with a printer unnecessary.

(0005)

According to the label printing method of this invention it is possible for example to use a laser light with a specific power of laser rays having said specific characteristics. In addition, while said optical disk is rotated, said optical pickup can be moved in the direction of the radius of the optical pickup. Further, when said optical disk is brought to a stationary status, it is also possible to move said optical pickup in the radial direction of the optical disk and in the track linear direction, which is orthogonal to the radial direction of the optical disk.

(0006)

The optical disk of this invention is equipped with a relative movement mechanism enabling the relative movement along the surface of an optical disk of laser light emitted from an optical pickup, and of an optical disk, set so as to face the side of incident laser rays striking the label surface on a turntable, with a laser modulation circuit, which modulates specific characteristics of laser light emitted from said optical pickup, and a with control circuit, which controls said laser modulation circuit and said relative movement mechanism. Said control circuit controls said relative movement mechanism, relative movement of said optical disk and of said laser light is initiated, and said laser modulation circuit is controlled so as to print image data corresponding to letters, pictures or the like on a label surface of the optical disk. The laser light emitted from said optical pickup modulates with said image data said specific characteristics, and a corresponding image is formed in a location visible from the label surface side on the optical disk. Control is exercised to apply printing to a visible light reflection characteristics changing layer by changing the reflection characteristics of visible light through irradiation with laser light having said specific characteristics. This optical disk apparatus thus makes it possible to realize the label printing method of this invention.

(0007)

The optical disk apparatus of this invention is provided with said relative movement mechanism which can be equipped for example with a rotation driving apparatus enabling driving rotation of a turntable, and with w driving apparatus for driving in the radial direction, inducing movement of said optical pickup in the radial direction of said optical disk.

[page 7]

Because said control circuit controls both of said driving apparatuses, this makes it possible to control the relative movement of said optical disk and said laser light. Because in this case, said control circuit drives said rotation driving mechanism with a constant number of rotations, a specified driving amount can be maintained for each specified rotational position of said driving mechanism for the feed in the radial direction. In addition, the optical disk apparatus is also equipped with a peripheral direction detection position apparatus that detects the position in the peripheral direction of said optical disk, and with a radial direction position detection

apparatus detecting the position in the radial direction of the optical disk of the optical pickup. Said control circuits controls laser light emitted from said optical pickup and the detection position of both position detection apparatuses, making it possible to perform control by modulating said specific characteristics in accordance with image data such as letters or pictures so as to enable printing on the label surface of said optical disk. Further, the position information of said image data can be displayed with coordinate data created by combining the optical disk peripheral direction position with the optical disk radial direction position. Said peripheral direction position detection apparatus can be also equipped with a frequency generator, which generates a frequency signal corresponding to rotations performed by said rotation driving apparatus, and with a multiplier which multiplies the frequency of the signal generated by the frequency generator. Furthermore, said relative movement apparatus is equipped with a radial direction feed driving mechanism moving the optical pickup in the radial direction of said optical disk, and with a track linear direction feed driving mechanism, which moves the optical pickup in the track radial direction of said optical disk, orthogonal to the movement in the radial direction. Because said control circuit controls both drives when said turntable has been set to he stationary status, this makes it possible to control the relative movement of said laser light and of said optical disk. Because the optical disk apparatus is also equipped with a radial direction detection apparatus detecting the optical disk radial direction position of said optical pickup, and with a track radial direction position detection mechanism, which detects the optical disk track radial direction position in the movement direction of the optical disk radial direction of said optical disk, said control circuit can control the modulation of said specific characteristics in accordance with image data such as letters or pictures so as to enable printing on the label surface of said optical disk. Also, the position information of said image data can be displayed as a coordinate data created by combining the optical disk track linear direction position orthogonal to the optical disk peripheral direction of said optical pickup, with the peripheral direction position of the optical disk. Furthermore, said control circuit sets the tracking servo off and the focus servo on, enabling to control the relative movement of said optical disk and of said laser light.

[page 8]

Said control circuit can also control the oscillation driving of a tracking actuator of said optical pickup while relative movement of said optical disk and said laser light is performed. Moreover, the optical disk apparatus of this invention can be also an optical disk recording apparatus of a one-sided optical disk of the CD type of optical disk, for example of the CD-R (CD recordable), CD-RW (CD rewritable) type, or the like.

(0008)

The optical disk of this invention inseparably integrated with a visible light reflection characteristics changing layer enabling to change the reflection characteristics of visible light from the side of the label surface by irradiation with laser light having specific characteristics from the side of the label surface, in a location visible from the label surface side. The label surface printing method can thus be realized with this optical disk. Further, because the visible

light reflection characteristics changing layer is formed inseparably integrated with the optical disk, when compared to the label pasting method, this makes it possible to prevent occurrences of oscillations during rotations at high speed due to mass eccentricity, as well as to prevent occurrences of failures caused when the label is peeled off inside the drive.

(0009)

The optical disk of this invention can be provided for example with said visible light reflection characteristics changing layer making it possible to change the color of the layer with color changes induced by irradiation with laser light having said specific characteristics. In addition, it can be also a thermosensitive layer or a photosensitive layer as a layer whose color is changing. Further, said optical disk can be formed with a sequential film formation structure including a recording layer, a reflection layer, and a protective layer on a substrate so that said visible light reflection characteristics changing layer is formed between the reflection layer and the protective layer. An intermediate layer can be also formed between said reflection layer and said visible characteristics changing layer in order to improve the adhesion characteristics between the reflection layer and the visible light reflection characteristics changing layer, or there can be a direct junction between the intermediate layer and the visible characteristics changing layer. Further, between said reflection layer and said protective layer can be present a part of said visible light reflection characteristics changing layer, or a part of the directly joined reflection layer and protective layer can be formed as a fine admixture of these directly joined components. Because the optical disk has a part in which the reflection layer is directly joined with the protective layer, this makes it possible to improve tight adhesion characteristics. Also, the visible reflection characteristics layer can be opaque, and since it is desirable that the part containing the reflection layer be visible from the label side through the part in which the visible light reflection characteristics changing layer is not present, while the reflection layer is directly joined to the protective layer so as to enable easy focus adjusting on the reflection layer during printing on the label.

[page 9]

The part in which the visible light reflection characteristics changing layer is present, and the part in which the reflection layer and the protection layer are directly joined without the visible light reflection characteristics changing layer, formed with a finely intermingled structure, can be formed for example so that the visible light reflection characteristics changing layer creates a great number of spot shapes between the reflection layer and the protective layer, or so that a great number of aperture shapes is formed, while the reflection layer can be directly joined to the protective layer on the outer side of the dots or on the inner side of the apertures. In addition to the dot shape and the aperture shape formation it is also possible to use the concentric circle or linear stripe shape or the like. Further, the optical disk of this invention can be the reflection type of a recordable, single-sided surface optical disk such as a CD-R (CD recordable), or a CD-RW (CD rewritable) disk or the like.

(0010)

(Embodiment Mode of the Invention)

The following is an explanation of an embodiment mode of the present invention. Figure 1 is a drawing showing a partial cross-sectional view of an embodiment mode of the optical disk of this invention (the thickness of each layer is in reality different. In addition, an indication of the guiding slot is omitted from the drawing). The figure shows an example that is applicable to a CD-R disk according to this invention. This optical disk 10 is formed with a sequential film structure comprising a coloring matter layer (recording layer) 14 on one side of a transparent substrate 12 made of polycarbonate or the like, a reflection layer 16, a visible light reflection characteristics changing layer 18, and a protective layer 20. The entire structure is inseparably integrated. Except for the fact that the visible light reflection characteristics changing layer 18 is provided, the structure is identical to the construction of a common CD-R disk. The visible reflection characteristics changing 1layer 8 can be seen from the side of the label surface 22 through the transparent protective layer 20. Because when the visible light reflection characteristics changing layer 18 is irradiated with laser light having a specified power from the side of the label surface 22, this causes changes of the reflection characteristics of visible light from the side of the label surface 22 (changes of reflectance, spectrum, etc.) in the irradiated locations, for example so that the color of a photosensitive or thermosensitive material is changed (for instance so that coloring, such as black color, is acquired from white color, or coloring, such as black color or the like, is acquired from a transparent status, etc.), as enabled by the construction of the material layers (color changing layer, photosensitive layer, thermosensitive layer). If a photosensitive layer construction is created containing a photosensitive layer in the visible light reflection changing layer 18, for example with irradiation from the side of the label surface 22 by using a laser light having the wavelength of 780 nm, while photosensitivity is not induced with a power of the laser light below 1 mW, it is possible to use a photosensitive material so that photosensitivity and color change will be induced above 1 mW. In addition, if the construction of the visible light reflection characteristics changing layer 18 comprises a thermosensitive layer, it is possible to use for example a thermosensitive material so that thermosensitivity is not induced below 100°C, but so that thermosensitivity will be induced at temperatures higher than 100°C so as to cause a color change.

[page 10]

In addition, since during recording or playback of data on the optical disk, the laser light will be emitted from the side of the substrate 12, and most of it will be cut off by the reflection layer 16, the reflection characteristics of the visible light reflection characteristics changing layer 18 will not change.

(0011)

Further, if the adhesion characteristics between the reflection layer and the visible light

reflection characteristics changing layer are poor, an intermediate layer 24 can be deployed as shown in Figure 2. Material having optimal adhesive characteristics both with respect to the reflection layer 16 and to the visible light reflection characteristics changing layer 18 should be employed for the intermediate layer 24. It is also possible to form a shape consisting of a great number of fine dots as shown in Figure 3 in the visible light reflection characteristics changing layer 18 instead of employing an intermediate layer (for example with a circular shape or with non-circular shape with a diameter of one dot corresponding to several tens μm, formed for example by using the film copy technique or a similar technique). It is also possible to use instead the shape comprising a great number of fine dots an aperture formation shape having a great number of fine holes 26 as shown in Figure 4. If the formation is created with the dot shape indicated in Figure 3, the reflection layer 16 will be joined directly to the protective layer 20 on the outer side of the dot, or on the inner side of the hole when the formation uses the aperture shape shown in Figure 4. This makes it possible to improve adhesion characteristics. The visible light reflection characteristics changing layer 18 can be also an opaque layer, and since a partial view of the reflection layer 16 is enabled from the side of the label surface 22 through the part in which the visible light reflection characteristics changing layer 18 is not contained and in which the reflection layer 16 component is joined directly to the protective layer 20 component, this makes it possible to adjust the focus in a simple manner on the reflection layer 16 during printing on the label surface 22. In addition to the dot shape or the aperture shape it is also possible to employ a concentric circle construction or a linear stripe construction or the like.

(0012)

Figure 5 shows a partial cross-sectional view of another embodiment mode of the optical disk of the present invention (the thickness of each of the layers differs from reality and an indication of a guiding slot is omitted from the drawing). This figure indicates an example of a CD-RW disk applicable to the present invention. This optical disk 28 is formed with a sequential film formation on one side of a transparent substrate 30 made of polycarbonate or a similar material, comprising a dielectric layer 32, a recording layer 34, a dielectric layer 36, a reflection layer 38, a visible light reflection characteristics changing layer 40, and a protective layer 42,formed so that the entire structure is inseparably integrated. Except for the fact that the visible light reflection characteristics changing layer 40 is provided, the construction is identical to the construction of a common CD-RW disk. The visible light reflection characteristics changing layer 40 can be seen through a transparent protective layer 42 from the side of the label surface 44.

[page 11]

The visible light reflection characteristics changing layer 40 can be formed with the same construction as that of the visible light reflection characteristics changing layer 18 of the embodiment shown in Figure 1. In addition, an intermediate layer can be also deployed in order to improve the adhesion characteristics between the reflection layer 38 and the protective layer

42 in the same manner as shown in Figure 2. Further, the visible light reflection characteristics changing layer 40 can be formed again in the shape of many tiny dots in the same manner as shown in Figure 3, or the aperture shape having a great number of fine holes can be created in the same manner as shown in Figure 4, or the concentric circle shape or linear stripe shape or a similar shape can be formed.

(0013)

Figure 6 explains an embodiment mode of the optical disk apparatus of the present invention (only the part relating to printing on the label surface is shown). This example is applicable to the construction of a CD-R/RW drive that can be used connected to a host computer such as a personal computer (an optical disk recording apparatus enabling recording and playback of data on a CD-R disk and a CD-RW disk). In a CD-R/RW drive 48 of the optical disk 50 of the present invention (the CD-R disk 10 of Figure 1 ~ Figure 4, the CD-RW disk 28 of Figure 5, etc.), the optical disk is mounted on a turntable 54 with a reversed top and rear surface side (so that the label surface 52 is facing downward), and driven and rotated by a spindle motor 56. A frequency generator (FG) 58 is coupled directly to the rotational axis of the spindle motor 56, so that a pulse signal (FG pulse) is generated for each rotational angle with a specified integral division per 1 rotation of the spindle motor 56 obtained from the frequency generator 58. The FG pulse is input to a system control circuit (CPU) 62 multiplied by a specified multiplier by a multiplying device 60 in a configuration comprising a PLL circuit, etc., utilized for detection of the disk peripheral direction position. A spindle servo circuit 64 exercises control with a constant number of rotations according to instructions for the number of rotations received from the system control circuit 62 for the spindle motor 56 based on the FG pulse when printing is applied to the label surface.

(0014)

Below the optical disk 50 is arranged an optical pickup 66 performing data recording, data playback and label printing operations. This optical pickup 66 is supported by a feed screw 68 so that free movement is enabled in the radial direction of the optical disk 50. A feed motor 72 is driven via a motor driver 70 based on the instructions obtained from the system control circuit 62, and because rotations are induced by the fed screw 68, the optical pickup 66 is moved in the radial direction of the optical disk 50. The optical disk radial direction position of the optical pickup 66 is detected by a feed position detector 74 based on a linear scale, etc. Because a focus servo circuit 76 maintains control according to the instructions of the system control circuit 62, a focus actuator of the optical pickup 66 is operated and focusing control is exercised.

[page 12]

When label printing operations are conducted, the focus servo circuit 76 is ON. The tracking servo circuit 78 drives the tracking actuator of the optical pickup 66 based on the tracking error signal according to the instructions from the system control circuit 62 and tracking control is thus performed during recording or playback of data. When printing to the label

surface is conducted, the tracking servo circuit 78 is OFF. An oscillation signal generating circuit 80 generates an oscillation signal specified by the instructions obtained from the system control circuit 62 when printing is applied to the surface label, and the signal is furnished to the tracking actuator. Because of that, the objective lens of the optical pickup 66 is oscillated in the radial direction of the optical disk 50 and the scanning interval is thus filled up with the laser light per each circumference, enabling to obtain printing without any gaps.

(0015)

The laser driver 82 drives a laser diode of the optical pickup 66 according to the instructions of the system control circuit 62, the optical disk 50 is irradiated with laser light and data recording, data playback and printing on the label surface is performed. Specifically, the laser diode creates irradiation with a recording power of the laser light modulated by the recording signal during data recording, laser light irradiation is created with a constant playback power during playback of data, and laser light is modulated with image data such as letters or pictures to be printed during printing on the label surface (so that laser light with a high power is created to generate changes in the visible light reflection characteristics changing layer in the part in which printing is performed, and laser light with a low power is created in order not to generate changes in the visible light reflection characteristics changing layer in the part in which printing is not performed).

When printing is applied to the label surface, the printing is edited by a user from the host computer 46 so as to print letters, pictures and other image data that is sent to the CD-R/RW driver. The structure of this image data can be expressed for instance with the radial direction position r of the optical disk (the distance from the center of rotations) and with the peripheral direction position θ (the angle in the peripheral direction to a suitable standard position), creating combined coordinates (r, θ), (for example so that normal data is created for a printing segment expressed by the angle θ per each radial position r of a specified pitch θr).

(0016)

The processing during which printing is applied to the label surface of the optical disk 50 with the CD-R/RW driver 48 of Figure 6 can be conducted for example as described below.

[page 13]

(1) The optical disk 50 installed in the turntable 50 for data recording or upside down for playback.

(2) A user edits letters, pictures and other images to be printed that are displayed on the display of a user computer. The edited images are converted to image data by host computer 46.

(3) The user indicates the start of a printing operation with host computer 46.

(4) The pulse generated from the frequency generator 58 is controlled so as to create a constant frequency with the instructions in the system control circuit 62 and the spindle servo circuit 64 controls the CAV (constant number of rotations) of the spindle motor 56.

(5) The optical pickup 66 determines the position in the reference position in the specified radial direction on the inner side of the optical disk 50.

(6) The laser power of the laser diode of the optical pickup 66 is controlled to create a specified low output with the instructions issued by the system control circuit 62 (with a value enabling focusing control without causing changes of the visible light reflection characteristics changing layer, for example a value above 1 mW), and the laser driver 82 operates the laser diode.

(7) The focus servo circuit 76 is set ON according to the instructions of the system control circuit 62. Because of that, the focus servo circuit 76 will apply focus servo operations so as to create the smallest spot of the laser light 67 in the reflection layer. In addition, the tracking servo circuit 78 remains set OFF so that tracking servo operations are not applied.

(8) When the above described preparation for printing is completed, printing will start according to the instructions obtained from the system control circuit 62. Specifically, the system control circuit 62 inputs image data from the host computer 46, the feed motor 72 is driven, it is determined that optical pickup 66 is positioned in the radial position of the initial printing location on the inner peripheral side of the optical disk 50, the reference position is created in the peripheral direction with a suitable timing based on the FG pulse (or with the detection timing of a separately employed detector used in order to detect the standard position in the peripheral direction), the output pulse of the multiplying device 60 is counted and the peripheral direction position θ is detected, and the operation is switched to a specified high output of laser power for each printing location in the peripheral direction according to the instructions of the image data for the radial position (with a value changing the visible light reflection characteristics changing layer, for example a value above 1 mW). Because of that, the reflection characteristics changing layer will be changed (through coloring, etc.) in locations irradiated with laser light at high power and printing will be conducted.

[page 14]

The optical disk 50 is rotated once, and after the operation has been returned to the standard position in the peripheral direction, the feed motor 62 is operated, optical pickup 66 is moved in the outer peripheral direction by a portion corresponding to a specified pitch Δr, and the operation is switched to high output to conduct printing with a specified laser power in each printing position in the peripheral direction indicated by image data in the radial direction. After that, these operations are repeated and printing is performed each time by moving the operation sequentially in the peripheral direction with the specified pitch Δr. Figure 7 indicates tracking of the laser light on the laser surface 52 of the optical disk 50 during printing operations. Printing is conducted by switching to laser power with a high output in the part drawn with a thick line.

Figure 8 explains the changes of the laser power when printing is conducted as shown in Figure 7.

[0017]

In addition, printing is conducted by moving the operation once until the radial position of the next printing location without scanning locations where no printing is performed. Also, when the size of the pitch Δr is large, even if an image is to be printed connecting in the original radial direction as shown in Figure 9, a gap is in the end created during printing. Since it is possible to create an inconspicuous gap if the size of the pitch Δr is small, the number of the circumferences required for printing on the entire label surface can be increased, but this means that the printing will in the end take a long time. Therefore, with the CD-R/RW driver 48 of Figure 6, a tracking actuator is driven with the oscillation signal (sinusoidal wave, triangular wave, etc.), generated from the oscillation signal generation circuit 80 during printing so as to oscillate the objective lens in the radial direction of the disk. Because of that, laser oscillations are induced in the radial direction of the disk as shown in Figure 10 and printing can be performed so that there will be no gap even if the pitch Δr is relatively large (or the gap will be small). The frequency of the oscillation signal can be set for example to several kHz. Also, the pitch Δr can be set for instance to 50 ~ 100 μm.

[0018]

Figure 11 (a) shows a real example of printing on the label surface with the CD-R/RW driver 48 of Figure 6. Figure 11 (b) indicates the status when the position of radius r1 is scanned, indicating an enlarged part of the locus of the laser light during printing with a high output of the laser light. Figures 12 (a), (b), (c) show other examples of printing on the label surface with the CD-RW driver 48. Any information such as the disk title, the name of a melody, or the name of the artist or the like can be printed with letters or pictures, etc.

[page 15]

(0019)

Figure 13 shows another embodiment mode of the optical disk apparatus of this invention (only the part contributing to printing on a label surface is shown). The optical disk is loaded to the CD-R/RW driver 84 and the optical disk 50 of this invention (CD-RW driver 10 of Figure 1 ~ Figure 4, CD-RW disk 28 of Figure 5, etc.)is set upside down on the turntable (so that the label surface 52 is facing downward). The spindle motor 88 is not driven when printing is conducted. An optical pickup performing data recording and data playback is arranged below the optical disk 50. The optical pickup 90 is supported by a feed screw 92 so that it can move freely in the radial direction of the optical disk 50. According to the instructions from the system control circuit 62, feed motor 94 is driven with the motor driver 96 and by rotating the feed screw 02, the optical pickup 90 is moved in the radial direction of the optical disk. The radial direction position of the optical pickup 90 is detected with a feed position detector 98, such as a linear screw or the

like.

(0020)

The mechanism providing feed in the disk radial direction having a feed screw 92 and a feed motor 94 is supported by a feed screw 101 arranged parallel to the surface of the disk 50 and orthogonally to the feed screw 92, enabling free movement in the track linear direction of the entire track unit. According to the instructions of the system control circuit 105, the feed motor 103 is driven with the motor driver 107, and by rotating the feed screw 101, the optical pickup 90 is moved in the track linear direction. The position in the track linear direction of the optical pickup 90 is detected with a feed position detector, such as a linear scale or the like.

(0021)

Figure 14 shows the arrangement of the feed mechanism (without indicating the feed motor and the feed screw). In the mechanism of the CD-R/RW driver 84, slide bars 111 are arranged in a fixed position parallel to the surface of the optical disk 50. Slide bars 111 thus provide slidable support for an optical pickup unit 113. The optical pickup unit 113 is transferred along the slide bar 111 with the feed screw 101 (Figure 13) and with the feed motor 103.

[page 16]

Slide bars 115 are arranged in a fixed manner orthogonally to the slide bars 11 and in parallel to the surface of the optical disk 50 in the optical pickup unit 113. Optical pickup 90 is supported in a slidable manner by the slide bars 115. Optical pickup 90 is moved along the slide bar 115 with a feed motor 94 and with a feed screw 92 (Figure 13). The mechanism enables driving in both directions during printing. When data is recorded or during playback of data, the feed mechanism can be driven only in the track linear direction, and the track linear direction feed mechanism is stopped in its intermediate position (the position to which the objective lens 90a of the optical pickup 90 can be moved in the disk radial direction with the feed mechanism for the track radial direction).

(0022)

In addition, the feed mechanism for the track linear direction can also use a spindle motor 88 instead to move the optical pickup 90. In this case, instead of the feed screw 101 and feed motor 103 transferring optical pickup 90 in the track linear direction as shown in Figure 13, a feed screw 117 and a feed motor 119 are deployed for transferring in the same direction with the spindle motor 88. Figure 15 shows an arrangement example of the moving mechanism in this case (the feed motor and the feed screw are not shown in this figure). In the mechanical base of the CD-R/RW drive 84, spindle motor 88 is supported in a slidable manner by slide bars 121, which are deployed in a fixed manner parallel to the surface of the optical disk 50. Spindle motor 88 is supported so as to enable sliding by the slide bars 121. Spindle motor 88 enables movement along the slide bars 121 with a feed motor 119 and a feed screw 117 (Figure 13). In

the mechanical base of the CD-R/RW drive 84, slide bar 123 are arranged in a fixed manner. The optical pickup 90 is supported in a slidable manner by the slide bars 123. The optical pickup 90 is moved along the slide bars 123 with a feed motor 94 and with a feed screw 92 (Figure 13). The feed mechanism can be driven in both directions during printing. The feed mechanism can be driven only in the track linear direction during recording and during playback of data. The feed mechanism for the tracking linear direction is stopped in its intermediate position (the position to which the objective lens 90a of the optical pickup 90 is moved in the disk radial direction with the driving of the feed mechanism for the track radial direction).

(0023)

[page 17]

As shown in Figure 13, the focus servo circuit 125 performs focusing control and drives the focus actuator of the optical pickup 90 based on the focus error signal according to instructions obtained from the system control circuit 105. When printing to the label surface is performed, the focus servo circuit is ON. The tracking servo circuit 127 drives the tracking actuator of the optical pickup 90 based on the tracking error signal according to instruction obtained from the system control circuit 105 during recording or during playback of data and tracking control is performed. During printing to a label surface, the tracking servo circuit 127 is set OFF. The oscillation signal generator 129 generates oscillation signal specified according to instructions obtained from the system control circuit 105 when printing to the label surface is conducted, and supplies it to the tracking actuator. Because of that, the objective lens of the optical pickup 90 is oscillated in the radial direction of the optical disk and because the laser light fills up the scanning intervals per each circumference, printing can be obtained without gaps.

(0024)

The laser driver 13 drives the laser diode of the optical pickup 90 according to the instructions obtained from the system control circuit 105, the optical disk 50 is irradiated with laser light and printing to the label surface is conducted during data recording and during playback of data. Specifically, because the laser diode drives the laser driver 131, the laser light is emitted with the recording power with the modulation created by the recording signal during data recording, the laser light is emitted with a constant playback power during data playback, and during printing to the label surface, the laser light is emitted modulated by image data such as letters, pictures, etc., to be printed (a high power is created so as to generate changes in the visible reflection characteristics changing layer in the part in which printing is performed, and a lower power of laser light is created when changes are not generated in the visible light reflection changing characteristics in the part in which printing is not performed). During printing to the label surface, image data such as letter, pictures, etc., which are to be printed, are edited by a user using a host computer, and sent to the CD-R/RW drive. This image data can be displayed for

example with coordinates (r, t), by combining the radial direction position r of the optical disk (the distance from a suitable reference position in the radial direction of the disk, such as the center of rotations), with position t in the track linear direction (the distance from a suitable position in the track linear direction), creating a dot matrix structure (for example of data specified in printing intervals in the track linear direction expressed by t, and expressed by r per each radial position of a specified pitch Δr).

[page 18]

(0025)

The following printing stages can be performed by way of an example during printing to the label surface of the optical disk 50 with the CD-R/RW drive 84 of Figure 13.

(1) During recording of data or during playback of data, optical disk 50 is mounted on the turntable 86 upside down.

(2) Images such as letters and pictures to be printed are edited by a user using a host computer 133. The edited images are converted to image data by host computer 133.

(3) The start of printing operations is indicated by a user with the host computer 133.

(4) Spindle motor 88 stops the printing operation according to indications obtained from the system control circuit 105.

(5) A specified reference position is determined on the optical pickup 90.

(6) The laser power of the laser diode of the optical pickup 90 is set to a low output specified with the instructions of the system control circuit 105 (with a value suitable for focusing control without changing the visible reflection characteristics changing layer, for example to a value below 1mW), and the driver 131 drives the laser diode.

(7) The focus servo circuit 125 is set ON with the instruction of the system control circuit 105. Because of that, the focus servo circuit 125 will apply focus servo so as to create the smallest spot 91 of the laser light in the reflection layer. In addition, the tracking servo circuit 127 is maintained in the OFF status and tracking servo is not applied.

(8) When the above described preparation for printing is completed, printing starts according to the instructions of the system control circuit 105. Specifically, the system control circuit 105 inputs image data from the host computer 133, the feed motor 94 is driven and the position in the disk radial direction is determined as the initial printing location position on the internal peripheral side of the optical disk 50 in the optical pickup 90. In this disk peripheral direction position, the motor 103 (or 119) is driven and laser light is moved in the track linear direction. The laser power is switched to a specified high output in the printing segment in the track linear

direction according to the instructions of image data for this disk radial direction position (with a value changing the visible light reflection characteristics changing layer, for example a value above 1 mW). Because of that, laser light with a high output will change the reflection characteristics changing layer in the irradiated location (causing discoloration, etc.), and printing is conducted.

[page 19]

Next, the feed motor 94 is operated and the optical pickup 90 is moved by a specified pitch segment Δr in the outer peripheral direction. In this position, while movement in the track linear direction occurs, the operation is switched to a specified high laser power output in the printing segment of the track linear direction according to the instruction of the image data, and printing is conducted. After that, these operations are repeated and printing is conducted sequentially with movement in the outer peripheral direction according to a specified pitch Δr. Figure 16 shows an example of tracing of the laser light on the label surface 52 of an the optical disk 50 and of completed printing with these printing operations. Since the movement takes place while the laser light is oscillated with an oscillation signal, printing that is free of gaps (or with few gaps) can be achieved.

(0026)

In addition, although the visible light reflection characteristics changing layer was arranged between a reflection layer and a protective layer in the above described embodiment mode, the optical disk of this invention is not limited to this arrangement as the visible light reflection characteristics can be also arranged in another location that is visible from the outer label surface of the optical disk (for example on top of the protective layer). Further, although it was explained that the visible reflection characteristics changing layer is formed with an indivisibly integrated construction in the above described embodiment mode to apply printing to the optical disk of this invention, the printing with this invention is not limited by this label surface printing method or by this optical disk apparatus. Specifically, printing can be also applied with a suitable optical disk apparatus or with the label surface printing method of this invention to an optical disk so that the visible light reflection characteristics changing layer is constructed so that a label is pasted on the label surface. In addition, although printing to a label surface was conducted while focus servo was applied in the embodiment mode described above, printing can be also conducted without applying focus servo in cases when a high resolution of printing is not required. Since in this case it is not necessary to obtain the reflection light that is needed for focus servo, the visible light reflection characteristics changing layer can be formed in an opaque mode so that one cannot see through the reflection layer. Also, although printing was conducted by modulating the power of the laser light in accordance with image data in the embodiment mode above, printing can be also performed with modulation of other parameters of laser light than power, enabling to achieve changes of the visible light reflection characteristics changing layer corresponding to image data. Further, although a color change was indicated as the change of the visible light reflection characteristics changing layer in the example explained in the embodiment mode above, the invention is again not limited by this since other changes can

be also recognized visually.

[page 20]

Also, although sequential printing was applied from the inner peripheral side to the outer peripheral side of the disk in the embodiment mode described above, the invention is not limited by this as printing can be also conducted from the inner peripheral side to the outer peripheral side or in another suitable order. Further, although printing was explained on the example of a CD-R disk or a CD-RW disk, this invention can be also applied to other cases when printing is applied to an optical disk. Moreover, while the invention is suitable for cases when an optical disk apparatus is connected to a host computer, this invention is again not limited by this, as it is also suitable for optical disk apparatuses that are used simply with a CD recorder or the like.

(Brief Explanation of Figures)

(Figure 1) A partial, cross-sectional view showing an embodiment mode of the optical disk of this invention.

(Figure 2) A partial, cross-sectional view showing a modified example of the optical disk of Figure 1.

(Figure 3) A partial, cross-sectional view showing another modified example of the optical disk of Figure 1.

(Figure 4) A partial, cross-sectional view showing yet another modified example of the optical disk of Figure 1.

(Figure 5) A partial, cross-sectional view showing another modified embodiment mode of the optical disk of this invention.

(Figure 6) A system configuration block diagram showing an embodiment mode of the optical disk apparatus of this invention.

(Figure 7) A top view diagram explaining tracing with laser light on the label surface with printing operations on a label surface using the CD-R/RW drive of Figure 6.

(Figure 8) A diagram showing changes of laser power when printing is conducted according to Figure 7.

(Figure 9) A top view showing tracing of laser light on a label surface when printing is conducted without oscillating the laser light in the disk radial direction.

(Figure 10) A top view showing tracing of laser light on a label surface when printing is conducted with oscillations of the laser light in the disk radial direction.

(Figure 11) A top view showing an example of printing on a label surface with the CD-R/RW driver of Figure 6.

(Figure 12) A top view showing another example of printing on a label surface with the CD-R/RW drive of Figure 6.

[page 21]

(Figure 13) A system configuration block diagram showing another embodiment mode of the optical disk apparatus of this invention.

(Figure 14) A top view and a front view showing an arrangement example of the CD-R/RW drive feed mechanism of Figure 13.

(Figure 15) A top view and a front view showing an arrangement example of the CD-R/RW drive of Figure 13.

(Figure 16) A top view showing an example of printing on a label surface with the CD-R/RW drive of Figure 13.

(Explanation of Figures)

10, 28, 50 ... optical disk, 14, 34 ... recording layer, 16, 38 ... reflection layer, 18, 40 ... visible light reflection characteristics changing layer, 20, 42 ... protective layer, 22, 44, 52 ... label surface, 24 ... intermediate layer, 26 ... hole, 48, 84 ... CD-R/RW drive (optical disk apparatus), 54, 86 ... turntable, 56 ... spindle motor (rotation driving apparatus), 58 ... frequency generator (peripheral direction position detection apparatus), 60 ... multiplying device, 62, 105 ... system control circuit (control circuit), 66, 90 ... optical pickup, 67, 91 ... laser light, 68, 72, 92, 94, 101, 103, 111, 11, 115, 117, 119, 121, 123 ... relative movement mechanism, 72, 94 ... feed motor (radial direction feed drive apparatus), 74, 98 ... feed position detector (radial direction position detection apparatus), 76, 125 ... focus servo circuit, 78, 127 .... tracking servo circuit, 80, 129 ... oscillation signal generating circuit, 82, 131 ... laser driver (laser modulation circuit), 103, 119 ... feed motor (track linear direction fee drive apparatus), 109 ... feed position detector (track linear direction position detector).

[Figure Page 1]

Document Name: Figures

Figure 1

22 label surface
10: optical disk (CD-R)
20: protective layer
18: visible light reflection characteristics changing layer
16: reflection layer
14: coloring matter layer (recording layer)

Figure 2

24: intermediate layer

[Figure Page 2]

Figure 3

Figure 4

[Figure Page 3]

Figure 5

44: label surface
28: optical disk (CD-ROM)
40: visible light reflection characteristics changing layer
38: reflection layer
36: dielectric layer
34: recording layer
32: dielectric layer
30: substrate

[Figure page 4]

Figure 6

50: optical disk
67: laser light
76: focus error
focus servo
74: feed position detection, r information
48: CD/CE drive
52: label surface
56: spindle motor
58: frequency generator (FG)
66: optical pickup
68: feed screw
72: feed motor
70: motor drive
62: system control ↔ image data (r, θ)
48: host computer
78: tracking surface
FG pulse
64: spindle motor
60: multiplying
80 oscillation signal generation
θ information

[Figure Page 5]

Figure 7

(1) reference position in the circumferential direction
(2) laser light locus
(3) segment in which printing is conducted by setting the laser power to high output
(4) 52: label surface
(5) trace direction
(6) disk center

[Figure Page 6]

Figure 8

radius r1
radius r1 + Δr
radius r1 + 2 Δr

(1) reference position
(2) "H": high laser power
"L": low laser power
(3) circumferential direction

(Figure 9)

(4) laser light locus
(5) 52: label surface
(6) printing location
(7) gap
(8) radial direction
(9) peripheral direction

[Figure Page 7]

Figure 10

52: label surface
(1) radial direction
(2) circumferential direction
(3) laser light trace
(4) printing location
(5) non-printing location

[Figure Page 8]

Figure 11 (a)

52: label surface
5: optical disk

Figure 11 (b)

high-output laser light trace

[Figure Page 9]

Figure 12

[Figure Page 10]

Figure 13

50: optical disk
91: laser light
90: optical pickup
focus error
125: focus servo
98: feed position detection
84: CD-R/RW drive
105: system control ↔ image data (r, t)
133: host computer
52: label surface
88: spindle motor
117: feed screw
101: feed screw
119: feed motor
103: feed motor
92: feed screw
94: feed motor
tracking error
127: tracking servo
131: laser driver
129: oscillation signal generation
107: motor driver
109: feed position detection

[Figure Page 11]

Figure 14

(Top View)

(Front View)

[Figure Page 12]

Figure 15

(Top View)

(Front View)

[Figure Page 13]

(1) trace of laser with a high output
(2) track linear direction
(3) disk radial direction
(4) (Operation During Printing)

50: optical disk
52: label surface

[Summary Page]

Document Name: Summary

Summary

Task

To perform printing on the label surface of an optical disk by using laser light of an optical disk apparatus.

Solution Means

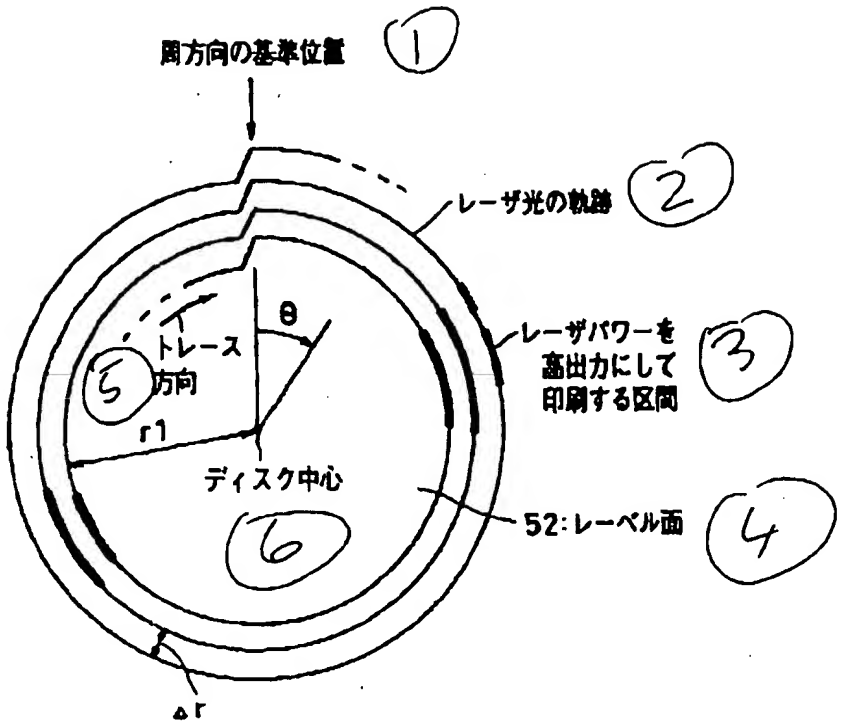
A visible light reflection characteristics changing layer is formed from a photosensitive material or a thermosensitive material in a location visible from the side of the label surface of an optical disk. On the turntable of the optical disk apparatus is set an optical disk so that the label surface is facing downward. Relative movement of the optical disk and of the optical pickup is induced along the surface of the optical disk. The power of the laser light emitted from the optical pickup, synchronized with this relative movement, is modulated in accordance with image data such as letters or picture or the like to be printed, and irradiation is applied to the visible light reflection characteristics changing layer. Due to the irradiation with the laser light, changes of visible light reflection characteristics are induced in the visible light reflection characteristics changing layer, and a corresponding image is printed on the label surface.

Selected Figure: Figure 1

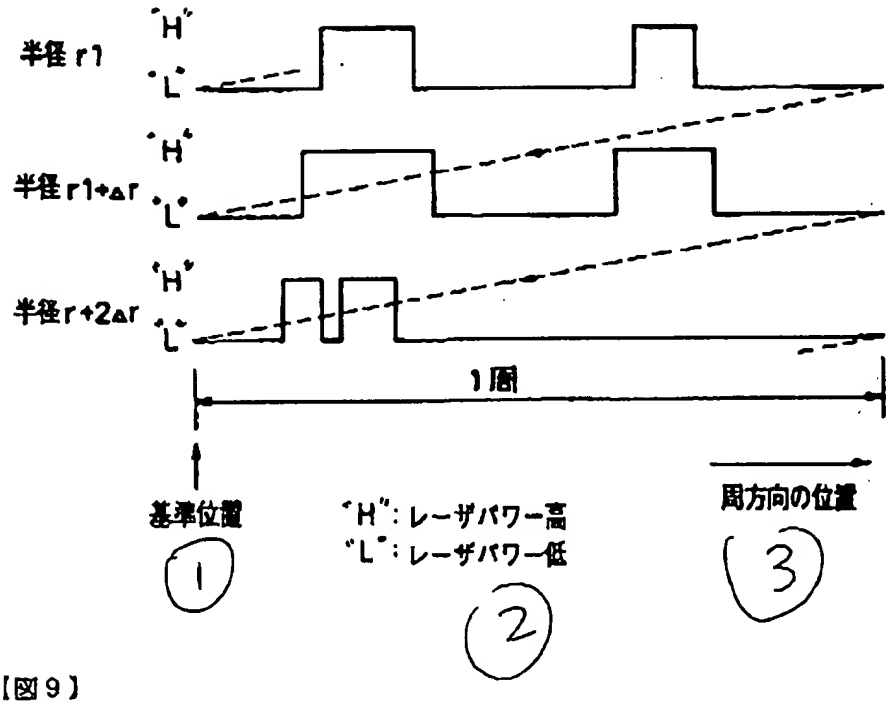
Application History Information

Identification Number:	(000004075)
1. Date of the Change:	August 22, 1990
(Reason for Change)	New Registration
Address:	Shizuoka-ken, Hamamatsu-shi, Nakazawa-cho, 10-ban, 1-go
Name:	Yamaha K. K. Company

【図７】


周方向の基準位置
1
レーザ光の軌跡
2
θ
トレース
方向
5
r1
ディスク中心
6
レーザパワーを
高出力にして
印刷する区間
3
52:レーベル面
4
Δr

【図８】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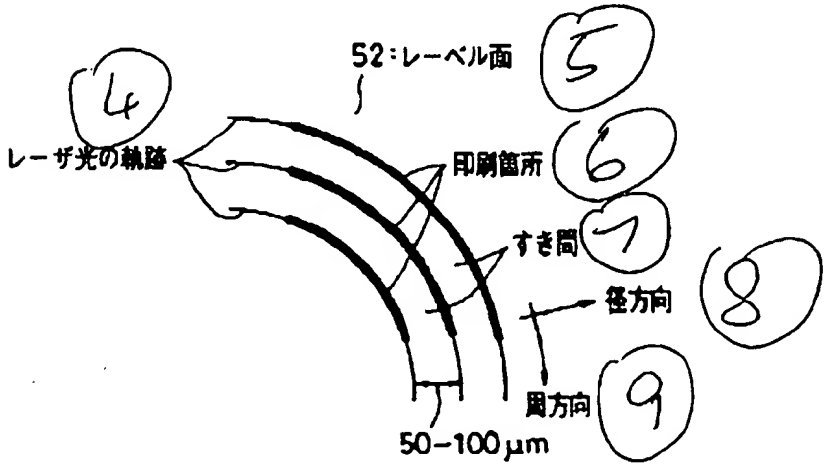
半径 r1+Δr
半径 r+2Δr
"H"
"L"
1周
基準位置
"H": レーザパワー高
"L": レーザパワー低
周方向の位置
1
2
3

【図９】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径方向
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4
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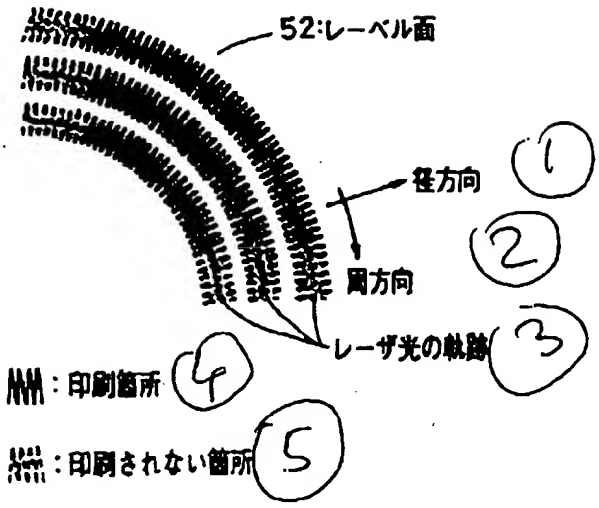
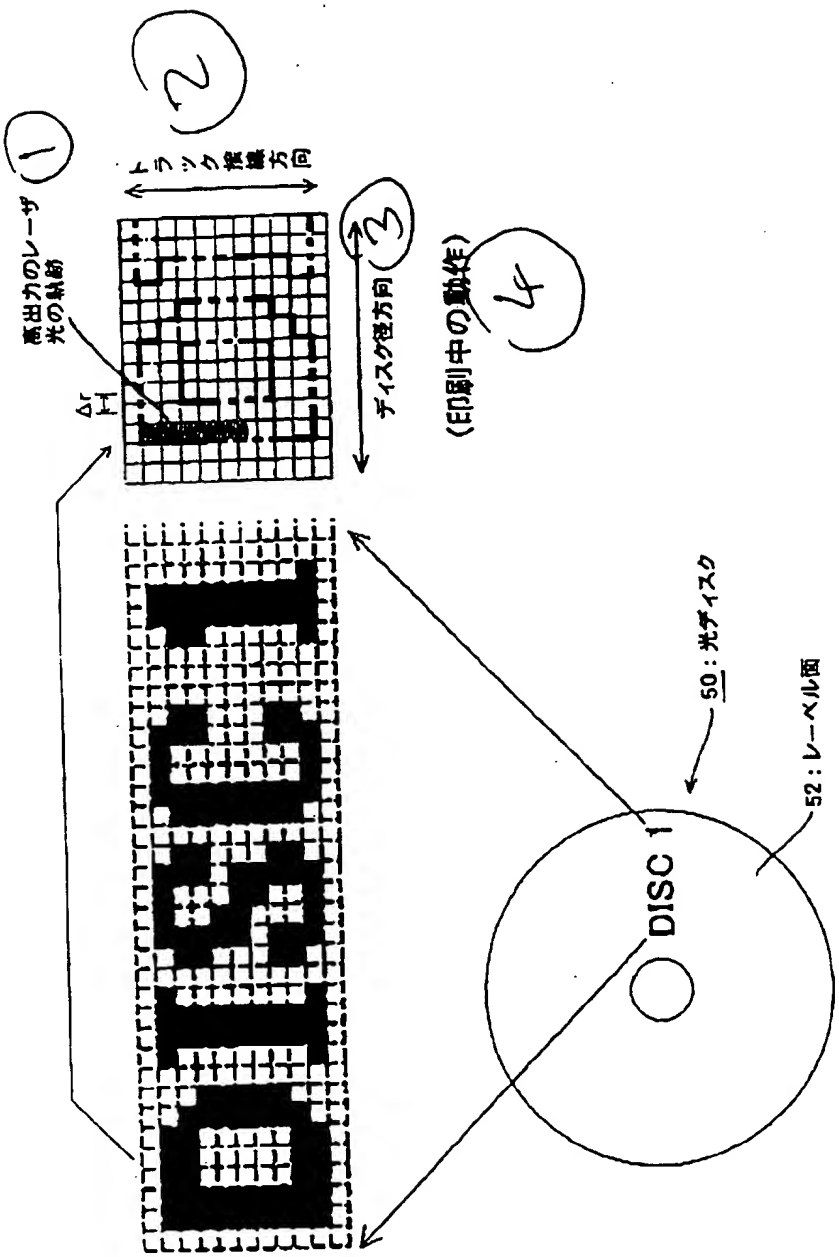
6
7
8
9

【図１０】



【図１６】


(1)
(2)
(3)
(4)
高出力のレーザ光の軌跡
トラック接線方向
ディスク径方向
(印刷中の動作)
Δr
H
50：光ディスク
52：レーベル面
DISC 1